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Review of Recent Literature

A NEW FAMILY OF CARNIVOROUS PLANTS

by J.A. Mazrimas

Givnish, T.J., E.L. Burkhardt, R.E. Happel, and J.D. Weintraub.

Carnivory in the Bromeliad *Brocchinia reducta,* with a cost/benefit model for the general restriction of carnivorous plants to sunny, moist, nutrient-poor habitats.

The American Naturalist *124,* No. 4: 479-497 1984

What really is a carnivorous plant? The authors of this paper propose a two part definition which is as follows:

The plant must be "able to absorb nutrients from dead animals juxtaposed to its surfaces, and thereby obtain some increment to fitness in terms of increased growth, chance of survival, pollen production, or seed set.

Second, the plant must have some unequivocal adaptation or resource allocation whose primary result is the active attraction, capture, and/or digestion of prey."

For some time, observers of the tropical forest canopy noticed the cup-like structure (called a tank) of epiphytic bromeliads which provide the opportunity to store not only water but many forms of animal life which accidentally fall in and drown and eventually decay into simple nutrients. The question is whether these plants are benefiting by this passive capture which is the subject of this paper.

In the definition above, the first portion divides the plant kingdom into those plants that kill or immobilize an insect just for defensive purposes such as *Roridula gorgonias*. Here, the sticky tentacles trap the insect as a defensive measure. Eventually, the leaf falls off the plant and the insect decomposes in the soil at the base of the plant. The second part of the definition restricts this type of activity being recognized as carnivory since nematodes and earthworms eventually die and decompose into simple nutrients that plants utilize.

There are 16 recognized genera of carnivorous plants either on logical or historical reasons. Not all of them fulfill the above definition. Some lack the attractants for trapping prey (*Lentibulariaceae*) and others lack digestive glands and rely on bacteria for digestion (*Heliamphora* and *Darlingtonia*). Most Bromeliads fall into the category of saprophytes because they lack the means to attract, digest prey and the means to prevent insect escape.

The *Brocchinia* bromeliad grows on a sterile sandstone surface in the Gran Sabana in southeastern Venezuela. It grows on the tepuis, flat-topped highly acidic sandy soil areas, about 3,600 feet (120 Ometers) and above the forest floor. Interestingly, it grows next to *Heliamphora*, *Drosera*, *Utricularia*, and *Genlisea* all of which are known carnivorous plants. It's a very common plant belonging to a genus with 18 known species and is found not only in Venezuela but also Guayana, but generally restricted to the Guyana Highlands.

What does the plant look like? The plant is about 12 inches (32 cm) in height and its yellowish-green leaves form a cylinder with the edges of the leaves overlapping tightly to retain water in the tank. The inside leaf surface is coated with a fine waxy powder which easily loosens when insects try to escape. The author demonstrates this with ants that failed to negotiate the vertical walls even though they could easily climb glass surfaces. The

Brocchinia reducta in habitat, Southeastern Venezuela.
Photos by T.J. Givnish, Harvard University.

fluid inside the tank is very acidic with a pH of 2.8-3.0. Microscopic examination of the plant showed no evidence for digestive glands.

The biomass within the tank was mostly ants (90%) and flies (5%) which is consistent with the fact that the tank fluid emits a sweet, nectarlike odor attractive to ants. This *Brocchinia* species is the only one of four others tested that had such a strong scent.

Trichomes, microscopic structures composed of specialized cells, are common in the Bromeliad family since they are capable of absorbing mineral nutrients essential to the well-being of epiphytic species. In *B. reducta,* these structures are very numerous at the inside base of the leaves and were shown to absorb amino acids in a radioactive form.

Protocarnivorous plants are those plants that have many of the preadaptations for attraction, capture, or digestion, but each of these traits may have other purposes with no clear allocation devoted solely to carnivory. Several species of Bromeliads fall into this category. The authors emphasize that the real crucial step for *B. reducta* is that it is capable of leaking a sweet smelling, volatile substance into its tank from glands in its leaf bases. They feel the key trait is attracting insects to the tank and this promoted the evolution of all the other functions that a true carnivorous plant must have.

This new representative of the carnivorous plant group is the least specialized of all the known carnivorous plants. It lacks digestive glands, specialized nectaries and has only a rudimentary waxy cuticle enclosing its water tank (lacks the bristles found in *Sarracenia*). Its traps are composed of single leaves formed into a rosette but retains the capacity to replace individual leaves as one dies which is not the case in *Heliamphora.*

This plant is an interesting case because it belongs to a genus in which not all the species are carnivorous and therefore affords a way of studying the various steps in evolution toward carnivory.

There are three factors, according to the authors, that all carnivorous plants must have in their environment to survive:

1) A nutrient-poor soil
2) A sunny location
3) Seasonally moist soil

It's a fact that there are 60% less carnivorous epiphytic angiosperms than terrestrial types. *Nepenthes* (6 of 71 species) and *Utricularia* (12 out of 280 species) are epiphytic. This brings up another question: why are carnivorous plants carnivorous? There are 3 possibilities: First, the nutrients that are absorbed can elevate the rate and seasonal duration of photosynthesis. There is some evidence for this from controlled feeding experiments and careful measurements of the leaf mass. Secondly, carnivory increases flower and seed production. Thirdly, that mineral nutrition is partly replaced by organic nutrition. On this latter point, all available evidence points to the fact that mineral nutrition is the chief means by which carnivorous plants achieve growth. Possibility No. 2 could easily be inversely related to No. 1. The energy and nutrients from a few less leaves could easily be directed to producing more flowers or seed.

It seems rather elementary that in nutrient poor soils, carnivorous plants will do better in a sunny, moist habitat than in a shady or dry one provided there is no limit on nutrient availability. Epiphytes must also have a good source of moisture as *Nepenthes* vines do by contacting the moisture in the soil via roots. Epiphytic *Utricularia* grow in wet cloud forests where water stress is rare. However, bromeliads are frequently found on shady perches or if in a sunny location are usually subject to dessication. This may account for the low numbers of epiphytic carnivorous plants.

Another factor why epiphytes are selected against may be because of the benefits that these plants get from certain species of ants that protect the plant. The plant provides shelter and nectar and the plant receives in a passive manner a supply of nutrients into the various plant

recesses in the form of food wastes, dead nestmates, food storage, etc. When it is all added up, the benefits may outweigh the plant's ability or need to become carnivorous.

I am looking forward to the next article on this new member of the carnivorous plant family when the authors will go into detail on various aspects not covered in this report.

Kondo, K. and P.S. Lavarack. 1984. A cytotaxonomic study of some Australian species of *Drosera* L. (Droseraceae). Bot. J. Linnean Soc. 88:317-333.

Fifteen species are presented along with eleven new chromosome counts. Droseras in Australian present a large aneuploid series. The lowest chromosome number is *D. paleacea* with 2n=10, giving a new basic number x=5 for the genus. Several rearrangements within subsections of the genus are proposed. DES

Taylor, Peter. 1984. Two new bladderworts from South India. Proc. Indian Acad. Sci. (Plant Sci.) 93:99-103.

Two small annual terrestrial Utricularias are herein described for the first time for South India: *U. ceceilii* and *U. lazulaina* with complete botanical descriptions and line drawings. DES

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